

**\*\*TITLE\*\***

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## Constraints on $(\Omega_m, \Omega_\lambda)$ from strong lensing clusters

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**Abstract.** We use three strong lensing clusters to constrain the cosmological parameters  $\Omega_m$  and  $\Omega_\lambda$ . Recent HST observations of galaxy clusters reveal a large number of multiple images, which are predicted to be at different redshifts. We showed in a previous work that if it is possible to measure spectroscopically the redshift of many multiple images then one can constrain  $(\Omega_m, \Omega_\lambda)$  through ratios of angular diameter distances independently of any external assumptions. Using three strong lensing clusters, our combined results lead to tight constraints.

### 1. Introduction

Recent work on constraining the cosmological parameters using the CMB and high redshift supernovae seems to converge to a “standard cosmological model” favouring a flat universe with  $\Omega_m \simeq 0.3$  and  $\Omega_\lambda \simeq 0.7$  (Jaffe et al. 2001). However, these results are still uncertain and it is therefore important to explore other independent techniques to constrain these cosmological parameters.

The existence of multiple images – with known redshifts – of the same source allows to calibrate in an absolute way the total cluster mass deduced from the lens model. The great improvement in the mass modelling of cluster-lenses leads to the conclusion that clusters can also be used to constrain the geometry of the universe, through the ratio of angular size distances,  $E = D_{LS}/D_{OS}$  (O: observer, L: lens, S: source), which only depends on the redshifts of the lens and sources, as well as the cosmological parameters (Link & Pierce 1998).

### 2. Method and Application

In a previous work (Golse, Kneib, & Soucail 2001b), we minimized a  $\chi^2$  in the source planes to recover some parameters of the lens potential on a grid  $(\Omega_m, \Omega_\lambda)$ , using numerical simulations. We apply this method to 3 strong lensing clusters which show several systems of multiple images with determined redshifts:

- AC114:  $z_L = 0.312$ ,  $z_1 = 1.691$  (4 images),  $z_2 = 1.867$  (3 images),  $z_3 = 3.347$  (5 images) (Campusano et al. 2001),
- A2218:  $z_L = 0.175$ ,  $z_1 = 0.702$  (4 images),  $z_2 = 1.034$  (3 images),  $z_3 = 2.515$  (3 images) (Ebbels et al. 1998),
- A1689:  $z_L = 0.184$ ,  $z_1 = 1.834$  (4 images),  $z_2 = 4.868$  (2 images) (Golse et al. 2001a).

Fig. 1 shows the confidence levels on the cosmological parameters.

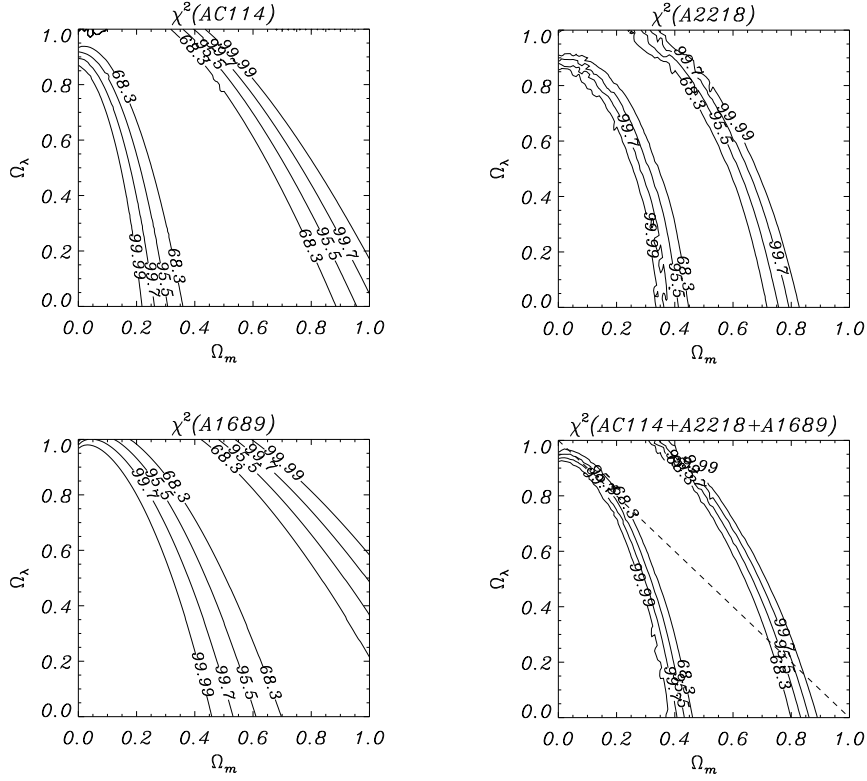


Figure 1.  $\chi^2$  confidence levels in the  $(\Omega_m, \Omega_\lambda)$  plane obtained in the optimisation of the potential of the cluster-lenses AC114, A2218, A1689, and a combined result of the three (dashed line:  $\Omega_m + \Omega_\lambda = 1$ ).

### 3. Conclusion

Combining the constraints from these 3 clusters lead to the Fig. 1 confidence levels. We obtain meaningful constraints compatible with a flat universe ( $\Omega_m + \Omega_\lambda = 1$ ). Since the exact degeneracy depends on the different redshift planes involved, results from other cluster lenses will further tighten the error bars. This test can be part of a joint analysis to improve the precision on the parameters.

### References

- Campusano, L. et al. 2001, astro-ph/0104477, A&A in press
- Ebbels, T. et al. 1998, MNRAS, 295, 75
- Golse, G., Castander, F., Soucail, G., Kneib, J.-P., 2001a, in preparation
- Golse, G., Kneib, J.-P., & Soucail, G. 2001b, astro-ph/0103500
- Jaffe, A. et al. 2001, Phys.Rev.Lett, 86, 3475
- Link, R., & Pierce, M. 1998, ApJ, 502, 63